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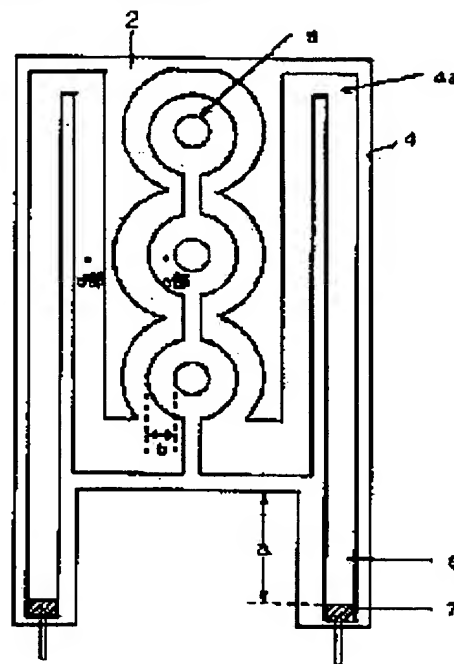
(72)Inventor : NAGASEKO RYUICHI

## (54) CONTACT-MAKING HEATER AND CONTACT-MAKING EQUIPMENT USING THE SAME

## (57)Abstract:

**PROBLEM TO BE SOLVED:** To improve temperature distribution of a heater itself for evenly conveying heat to a portion subjected to heating even if the heating temperature rises, by burying a heating resistor in such a manner that the resistor encircles an suction hole, which is used to suck an object to be subjected to heating, of a ceramic heater.

**SOLUTION:** A ceramic heater 2 consists of a square heating portion 4, a heating resistor 4a, a lead portion 6 which applies voltage to the heating resistor 4a, and an electrode lead 7 formed on the end of the lead portion 6, and is equipped with three suction holes 5 for sucking a semiconductor chip and a head 2. The wiring of a heating resistor 4a is buried in such a manner that it encircles an suction hole 5 so as to maintain the temperature around the suction hole 5. The distance (b) between the suction hole 5 and heating resistor 4a is desirably adjusted to 0.7 mm or less. As the heating temperature rises, the temperature of the electrode lead 7 also rises, which produces cracks, causing decrease in strength. To solve the problem, the distance (a) between the square heating portion 4 and the electrode lead 7 is increased to 10 mm or longer so as to lower the temperature of the electrode takeout portion.



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**CLAIMS**

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[Claim(s)]

[Claim 1] The heater for contact heating characterized by being formed so that said exoergic resistor may surround said attraction hole while having an attraction hole for adsorbing a heated object at this head section in the heater for contact heating which has an exoergic resistor for heating the head section and this head section for contacting a heated object.

[Claim 2] The heater for contact heating according to claim 1 characterized by the distance of said exoergic resistor and said attraction hole being 0.7mm or less.

[Claim 3] The heater for contact heating according to claim 1 characterized by for the electrode fetch section of said exoergic resistor projecting at least 10mm or more, forming it rather than the exoergic section, and carrying out low attachment of the lead wire near [ the ] a terminal.

[Claim 4] The heater for contact heating according to claim 1 characterized by being formed so that the resistance of the exoergic resistor near the lead section may become larger than the exoergic resistor of other parts.

[Claim 5] Contact heating apparatus which comes to have a means which carries out vacuum attraction by which it is open for free passage to an attraction hole using the heater for contact heating according to claim 1 to 4.

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## DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] This invention relates to the contact heating apparatus using the heater for contact heating and this which were made to carry out press heating of the heated objects, such as a heater head for bondings used in case direct bond of the semi-conductor bare chip is carried out on a substrate.

[0002]

[Description of the Prior Art] The flip-chip-bonding method which used low melting point lows, such as ACF continuation which used the adhesives of resin systems, such as anisotropy electric conduction film, or Au-Si which is used for a multi chip module, Au-Sn, and Pb-Sn, as an approach of carrying out direct bond of the semi-conductor bare chip on a substrate is performed. For example, in flip chip bonding, the semi-conductor bare chip was carried on the substrate of a multilayer package, and it has joined by pressing heating the heater for press heating with built-in or the combined hollow clay building block object from the top face. At this time, by the solder bump who prepared for both, while joining, wiring can be performed.

[0003] As such a heater for press heating, the thermally conductive high nature ceramics of alumimium nitride was used. This forms the heater for bondings in the rectangular body which consists of nature ceramics of alumimium nitride, and considers as the hollow clay building block object which makes the head side contact a semiconductor chip, and a back end side is make into the holder combine with other members, and after print heating elements, such as Ag-Pd and Pt-Pd, to a side face or the interior by the technique of thick film screen printing and be burn on it, it covers with a cover glass paste etc. ( thick-film type hollow clay building block object). Even a binder needs to conduct efficiently the heat for softening or fusing the binder of \*\* which makes a semi-conductor bare chip fix on the substrate of a multilayer package first as a property for which such a heater for bondings is asked through a semi-conductor bare chip.

[0004] Moreover, it is important that the heating up time from the point of productive efficiency to necessary temperature is short, and temperature decay time until the adhesives after bonding termination moreover solidify is also short. Furthermore, in case a semi-conductor bare chip is joined, in order to apply a pressure to heat and coincidence, a mechanical strength, and abrasion resistance or toughness is required of the hollow clay building block object of the heater for bondings. However, since the thermally conductive good nature ceramics of alumimium nitride was used in the case of the above-mentioned pressure membrane type hollow clay building block object, the problem [ heat / of a heating element ] that the heating effectiveness by the side of recess or the hollow clay building block object which becomes empty was bad was in the holder side.

[0005] Furthermore, since it was a pressure membrane type, the adhesion of a heating element and the ceramics was bad, since there was moreover a differential thermal expansion, while repeating the heat cycle of temperature up and a temperature fall, the exoergic resistor separated from the ceramics and nonconformity, such as producing an open circuit frequently, was.

[0006] Then, as shown in drawing 6 in recent years, a holder 1 is constituted from low heat-conduction ceramics. On the other hand, said holder 1 is made to fix the ceramic heater 2 which prepared exoergic resistor 4a in the interior. The heater for press heating of a method which makes a multilayer package substrate fix said semi-conductor bare chip with adhesives was developed by contacting the head 3 which furthermore consists of high temperature conduction ceramics on a ceramic heater 2, and carrying out press heating of said head 3 at a semi-conductor bare chip.

[0007] The pattern of exoergic resistor 4a of the conventional heater for press heating, the pattern of the lead drawer section 6, and the electrode fetch section 7 were shown in drawing 5 . As for exoergic resistor 4a, the meandering pattern is formed in the whole press side of a ceramic heater 2. Moreover, three attraction holes 5 are formed in the center section of said ceramic heater 2, and two of both sides are used as the object for head adsorption, and a central

attraction hole 5 for [ one ] semi-conductor bare chip adsorption.

[0008] Thereby, the heater for press heating with the good endurance of heating effectiveness and an exoergic resistor can be supplied now.

[0009]

[Problem(s) to be Solved by the Invention] Since three attraction holes 5 were formed in a part for a center section as exoergic resistor 4a used for the conventional heater for press heating is shown in drawing 5 , the meandering pattern of a center section formed the big clearance so that this attraction hole 5 might be avoided. While improvement in heating temperature is called for in recent years, improvement in the heating temperature of a ceramic heater is needed. Since the attraction hole 5 neighborhood radiated heat also from the interior of an attraction hole to the top with little calorific value as heating temperature rose, the surrounding temperature distribution of the attraction hole 5 became large, and the first technical problem that heat did not get across to a heated object uniformly occurred.

[0010] Moreover, since the heating temperature of a ceramic heater became high, the temperature of an electrode terminal area came to reach an elevated temperature 300 degrees C or more, and the 2nd technical problem that the endurance of the electrode fetch section 7 worsened occurred.

[0011] Furthermore, for the heat length from the lead drawer section, the temperature near the lead drawer section fell and there was the 3rd problem that the poor dissolution of adhesives, such as solder, occurred.

[0012]

[Means for Solving the Problem] The temperature distribution of the heater itself enabled it to solve the 1st technical problem that heat does not get across to a heated object uniformly bad, in this invention by laying an exoergic resistor underground so that the attraction hole for heated object adsorption may be surrounded.

[0013] Moreover, the endurance of the polar zone enabled it to solve the 2nd technical problem are bad, by setting distance from the exoergic resistor of a ceramic heater to the electrode fetch section to 10mm or more.

[0014] Furthermore, about the exoergic resistor of a heater, by enlarging the resistance near the lead section compared with other parts, the calorific value of the exoergic resistor near the lead section was made to increase, the temperature lowering by the heat length by the electrode fetch section was compensated, and the 3rd technical problem was solved.

[0015]

[Embodiment of the Invention] Hereafter, the gestalt of operation of this invention is explained using drawing 1 . Drawing 1 is drawing having shown the heating unit and the press section of the heater for press heating. The heater for press heating of this invention forms crevice 1a in the holder 1 which consists of low heat-conduction ceramics, and holds the ceramic heater 2 which laid exoergic resistor 4a under said crevice 1a. When using this heater for press heating, it is in the condition energized to exoergic resistor 4a, and stress is applied pressing against a semi-conductor bare chip the contact side of a head 3 established so that a ceramic heater 2 may be touched, and heating it, and a semi-conductor bare chip is joined by the solder bump on a multilayer package substrate. Since the ceramic heater 2 has joined the head 3 which consists of high temperature conduction ceramics to the front face at this time and heat can be told good, rapid temperature up becomes possible.

[0016] The pattern of exoergic resistor 4a formed in drawing 2 at the ceramic heater 2 of the heater for press heating of this invention was shown. A ceramic heater 2 consists of the rectangular exoergic section 4, exoergic resistor 4a, the lead section 6 for impressing an electrical potential difference to exoergic resistor 4a, and the electrode fetch section 7 formed in the end of the lead section 6. The lead wire which consists of nickel etc. further is connected to the electrode fetch section 7 by technique, such as low attachment. Furthermore, three attraction holes 5 for adsorbing a semiconductor chip and a head 2 are formed in the ceramic heater 2. Since the temperature of this attraction hole 5 circumference tends to fall, it is formed so that wiring of exoergic resistor 4a may enclose the attraction hole 5. The distance b between the attraction hole 5 and exoergic resistor 4a is preferably adjusted to 0.7mm or less. In addition, it is better for the whole to form this distance b in a uniform distance so that the maximum access distance between the attraction hole 5 and exoergic resistor 4a may be 0.7mm or less and may surround the attraction hole 5 preferably.

[0017] Although heating temperature was 300 degrees C, as for the conventional heater for press heating, the commercial-scene demand has been changing to 500-degree-C heating type recently. It is in the inclination for the temperature of the electrode fetch section 7 to rise as heating temperature becomes high. It turned out that a crack occurs in the electrode fetch section 7 by the heat cycle at the time of an activity, and the reinforcement of the electrode fetch section 7 falls by this. The dimension of the distance a between the exoergic section 4 of the rectangle shown in drawing 2 and the electrode fetch section 7 is made long to 10mm or more, and it was made to lower the temperature of the electrode fetch section 7 to 300 degrees C or less for solution of this point.

[0018] Drawing 3 shows another example of this invention. Formation of the lead section 6 becomes easy to reduce the surrounding temperature of the lead section 6 for the heat transfer which escapes through this part. In order to prevent

this temperature lowering, it is effective by narrowing pattern width of face of exoergic resistor 4a in the e section of the lead section 6 neighborhood like drawing 3 to make the resistance of exoergic resistor 4a high, and to make [ many ] calorific value.

[0019] Moreover, as for the circumference of the periphery section and the attraction hole 5, it is desirable to adjust the resistance of exoergic resistor 4a more highly than other parts.

[0020] As an operation gestalt of further others, the ring-like ceramic heater 2 which has a hole can also be used in the center as shown in drawing 4. This lays exoergic resistor 4a under the ceramic cylinder-like object, is equipped with lead wire 8, uses a central hole as an attraction hole 5, and makes a contact side the field of the opposite hand of lead wire 8. in this case -- as exoergic resistor 4a -- a line -- the body is used, and it has approached and laid underground so that this exoergic resistor 4a may enclose the attraction hole 5.

[0021] When using the heater for contact heating of the above this invention, having a vacuum attraction means by which it is open for free passage to the above-mentioned attraction hole 5, accomplishing with contact heating apparatus, and carrying out vacuum attraction, a heated object can be adsorbed and can be heated.

[0022] At this time, stress can be transmitted certainly, without carrying out elastic deformation, since it consists of ceramics, although compressive stress joins a holder 1 at the time of heating. And although it is necessary to hold the outstanding parallelism between holder 1 underside and a contact side, since all members consist of a ceramic ingredient of a high degree of hardness, high parallelism can be held. For this reason, it becomes joinable [ stable ] also at the time of junction of the semiconductor chip of a large area.

[0023] Furthermore, since exoergic resistor 4a is laid under the ceramic heater 2, even if it repeats temperature up and a temperature fall and a heat cycle is added, an open circuit of exoergic resistor 4a by thermal stress can be prevented.

[0024] The thermal conductivity in ordinary temperature uses the object 50W/m and more than K preferably that the ceramics which makes a ceramic heater 2 here has thermal conductivity higher than a holder 1, or what is necessary is just an equivalent ceramic. In addition, the thermal conductivity in this invention is a value in ordinary temperature, and is the value calculated with the laser flash method.

[0025] Moreover, it is also possible to attach in the structure where you may make it join the head 3 which consists of a highly thermally-conductive material further through adhesives on a ceramic heater 2 from a ceramic heater 2, it is held possible movable with other holders, and a ceramic heater 2 and a semiconductor chip are contacted at the time of press heating.

[0026] Moreover, since heated objects, such as a semi-conductor bare chip, are contacted, in order to raise abrasion resistance, as for the contact side of a ceramic heater 2, it is desirable that 500g [ of loads ] Vickers hardness uses the ceramics of 10 or more GPa as construction material of a ceramic heater 2.

[0027] Furthermore, in order to prevent the chip of a contact side, it is desirable that the fracture toughness value (KIC) which the three-point flexural strength specified to JIS measured by 300 or more MPa and the indentation method uses the 1/2 or more 4 MPa-m ceramics.

[0028] As ceramics with which are satisfied of these, there is ceramics, such as silicon nitride, aluminum nitride, and silicon carbide. The silicon nitride ceramics uses silicon nitride as a principal component, and is periodic-law the 3a. A group element (RE) by oxide (RE 2O<sub>3</sub>) conversion 3 - five-mol %, While aluminum consists of 0.2 or less % of the weight of a presentation by oxide conversion and the mean particle diameter of silicon nitride enlarges with 5 micrometers or more, it is periodic table the 3a to a grain boundary. The object which made thermal conductivity 50 or more W/m-K is desirable by forming the crystal phase containing a group element, silicon, oxygen, etc.

[0029] Moreover, the nature ceramics of aluminum nitride uses aluminum nitride as a principal component, and contains the oxide of rare earth elements etc. as sintering acid. further -- the quality of silicon carbide ceramics -- silicon carbide (SiC) -- a principal component -- carrying out -- B, C or aluminum 2O<sub>3</sub>, and Y<sub>2</sub>O<sub>3</sub> etc. -- sintering acid is contained.

[0030] For 10 or more GPa and flexural strength, also in these high temperature conduction ceramics, 300 or more MPa and a toughness value are [ especially Vickers hardness ] one half 4 MPa-m. If the above thing is used, the chip of a contact side can be controlled. It is optimal to specifically use high temperature conductivity silicon nitride.

[0031] Moreover, the contact side of the ceramic heater 2 needs to consider as a flat field, in order to stick with a heated object and to apply heat to homogeneity. As for a contact side, specifically, it is desirable to consider as the surface roughness of 0.5 micrometers or less and the display flatness of 1-5 micrometers, and to set parallelism between electrode-holder undersides to 2-5 micrometers.

[0032] As for the thickness of a ceramic heater 2, it is still more desirable to be referred to as 0.5-5mm. This is because it is it hard coming to maintain soak nature that heat capacity becomes large too much, a temperature-up property worsens, and it is 0.5mm or less on the other hand, when thickness exceeds 5mm. Moreover, in order to use the simple

substances of refractory metals, such as a tungsten and molybdenum, or those carbide, and silicide as construction material used for the exoergic section and the lead section of a ceramic heater 2 and to ease the difference of coefficient of thermal expansion, it is also effective in the improvement in endurance of exoergic resistor 4a to add the base material component of a ceramic heater 2 to the above-mentioned metal.

[0033] next, the low heat-conduction ceramics which accomplishes a holder -- a ceramic heater 2 and thermal conductivity -- an EQC -- or the thermal conductivity in ordinary temperature uses the thing of 50 or less W/m-K preferably that what is necessary is just an object with thermal conductivity lower than it. Low heat-conduction silicon nitride, an alumina, a zirconia, etc. can be used, and, specifically, in addition to this, various ceramics can be used.

[0034] if it explains still more concretely -- the low heat-conduction silicon nitride ceramics -- silicon nitride ( $\text{Si}_3\text{N}_4$ ) -- a principal component -- carrying out -- aluminum  $2\text{O}_3$  and  $\text{Y}_2\text{O}_3$  etc. -- it is possible to use what contains as sintering acid and has the grain boundary layer which is hard to crystallize. Moreover, alumina ceramics are aluminum  $2\text{O}_3$ . It considers as a principal component and  $\text{SiO}_2$ ,  $\text{MgO}$ ,  $\text{CaO}$ , etc. are contained as sintering acid. further -- zirconia ceramics --  $\text{ZrO}_2$  a principal component -- carrying out --  $\text{Y}_2\text{O}_3$ , and  $\text{MgO}$ ,  $\text{CaO}$  and  $\text{CeO}_2$  etc. -- it contains as sintering acid. moreover -- a zirconia -- reinforcement and toughness -- taking into consideration -- the above sintering acid -- 3-6-mol % -- it is good to use TZP to contain or partially stabilized zirconia.

[0035]

[Example] Example The example of 1 this invention is explained using drawing 1 and 2.

[0036] First, the process of a holder 1 is explained. The object made into width of face of 24mm and die length of 44mm was prepared using the low thermal conductivity silicon nitride of thermal conductivity 25 W/mK as construction material of a holder 1. Then, cutting of the crevice for joining a ceramic heater 2 was carried out so that width of face might serve as 20mm, die length of 24mm, and a depth of 1.5mm.

[0037] Next, the process of a ceramic heater 2 is explained. Print formation of the pattern of the exoergic resistor 4 and the lead section 6 was carried out on ceramic generation form 2a which consists of silicon nitride. What mixed with the binder and the solvent what used WC as the principal component and added suitably the silicon nitride ingredient homogeneous as a ceramic generation form as exoergic resistor 4a was used. Exoergic resistor 4a avoided the part used as three attraction holes 5, and it formed it so that the part used as the attraction hole 5 might be surrounded. The distance b of the attraction hole 5 and exoergic resistor 4a produced what carried out the variate between 0.3-2mm as shown in a table 1. Then, another ceramic generation form 2a' was stuck in piles, and it calcinated by the approach of a hotpress etc., and considered as the sintered compact. Then, the lead section 6 was formed by carrying out cut clearance of the pars intermedia of the two lead sections 6. Die-length a between the rectangular exoergic section 4 and the electrode fetch section 7 could be 10mm. Furthermore, hole processing of the attraction hole 5 was carried out at the position. The total thickness of a ceramic heater 2 was set to 3mm.

[0038] Next, the paste of the mixed powder of a glass presentation was applied to crevice 1a of a holder 1, the ceramic heater 2 was piled up upwards, and it unified by heat-treating at 1500-1700 degrees C among nitrogen-gas-atmosphere mind. Moreover, the electrode fetch section 7 carried out low attachment of the plate which consists of a Fe-nickel-Cr alloy which welded nickel line using the Au-Cu low.

[0039] Thus, to the produced sample, it energized so that the point d of the exoergic section 4 measuring the temperature might become 400 degrees C, and to it, the temperature gradient of the point d 5 seconds after after energization initiation measuring the temperature and the point c of the attraction hole 5 latest measuring the temperature was measured. Moreover, the distance b between the attraction hole 5 and the exoergic resistor 4 was measured with the transparency X wire method. Furthermore, the dimension was checked after measurement by carrying out the cross section of the part containing the attraction hole 5. The temperature of the point d measuring the temperature and the point c measuring the temperature was measured using the infrared ray radiation thermometer (thermostat viewer). The result was shown in a table 1.

[0040]

[A table 1]

サンプルNo.	距離b	温度差(d-c)	温度差判定	備考
1	2.0mm	20°C	×	
2	1.5mm	15°C	×	
3	1.0mm	13°C	×	
4	0.7mm	8°C	○	
5	0.5mm	5°C	○	
6	0.3mm	3°C	○	
7	従来	20°C	×	

[0041] As for No.1-3 which set distance b between the attraction hole 5 and exoergic resistor 4a to 1.0mm or more, a



temperature gradient becomes 10 degrees C or more. On the other hand, it turns out that 4-6 which are in the generic claim of this invention can make a temperature gradient small at 10 degrees C or less. Thereby, reliable flip chip junction is attained.

[0042] Example The variate of the distance a between the exoergic section 4 of two rectangles and the electrode fetch section 7 was carried out to 5-20mm, and the assessment sample was produced by the same technique as an example 1. Distance b between exoergic resistor 4a and the attraction hole 5 was set to 0.3mm. The junction dimension of a Fe-Cr-nickel plate and the lead fetch section 7 was set to 2mmx5mm, and used the Au-Cu low for low attachment. In this way, the temperature of the electrode fetch section 7 in the steady state at the time of heating the prepared sample so that the temperature of the point d of the exoergic section 4 measuring the temperature may become 500 degrees C was measured. The thermocouple of 0.2mm of wire sizes was fixed and measured with alumina cement into each part at the thermometry. Moreover, the lead data of the electrode fetch section 7 before and behind 5000 cycle \*\*\*\*\* on the strength were shown [ the exoergic section ] for the cycle of a forced-air-cooling 1 minute in a table 2 for 500-degree-C heating 2 minutes.

[0043]

[A table 2]

サンプルNo.	リード長さ a	発熱部温度	電極引出部	初期強度	耐久テスト 強度	破壊モード	判定
1	5mm	500℃	380℃	11kgf	6kgf	剥離	×
2	8mm	500℃	320℃	11kgf	8kgf	剥離	×
3	10mm	500℃	280℃	11kgf	11kgf	リード切れ	○
4	15mm	500℃	230℃	11kgf	11kgf	リード切れ	○
5	20mm	500℃	200℃	11kgf	11kgf	リード切れ	○

Ni線径:0. 6mm

[0044] Since the temperature of the electrode fetch section 7 goes up 2 to 300 degrees C or more as sample No.1 which set distance a between the exoergic section 4 and the electrode fetch section 7 to 5-8mm from the result of a table 2 and the tensile strength of the lead section after a cycle test falls, it is not desirable. On the other hand, since the temperature of the electrode fetch section 7 became 300 degrees C or less, there is no change of the tensile strength of the lead section after a cycle test, and, as for No.3-5 which are the generic claim of this invention, it turned out that good endurance is shown.

[0045] Example When printing the exoergic resistor 4 on the front face of 3 ceramic generation form 2a, what was formed at the rate of the same resistance ratio to near lead drawer section 6a, and the thing which adjusted resistance near lead drawer section 6a so that it might become large 10% by max compared with other parts were produced as usual. Other processes produced the sample like the example 1.

[0046] In this way, the temperature of the point e near the lead drawer section 5 seconds after impressing the power with which the temperature of the point d on the exoergic resistor 4 measuring the temperature becomes 500 degrees C to the produced sample measuring the temperature was measured using the infrared ray radiation thermometer (thermostat viewer). The result was shown in a table 3.

[0047]

[A table 3]

サンプル No.	電極引出部側発熱体の 断面積較り率	測温点d-e間の 温度差	備考
1	0%	10℃	
2	10%	<1℃	

[0048] As for the thing of this invention, the temperature gradient of the point e measuring the temperature and the point d measuring the temperature was able to reduce the cross section of the lead section at 1 degree C or less to the temperature of the point e measuring the temperature having become [ which was made into the same cross section ] low 10 degrees C from 490 degrees C and the point d measuring the temperature conventionally, as for elegance to the lead drawer section.

[0049]

[Effect of the Invention] It was able to become possible to make the temperature distribution of a head side into homogeneity by laying underground so that an exoergic resistor may be surrounded with an attraction hole like the above statement, and poor solder \*\*\*\* at the time of bare chip installation was able to be prevented. As for the distance between an exoergic resistor and an attraction hole, it is desirable to make it 0.7mm or less. Moreover, in order to maintain the soak nature of the exoergic section, as for the exoergic resistor near the lead section, it is desirable to make resistance high compared with other parts. Furthermore, as for the die length of the lead section, it is desirable to be

referred to as 10mm or more because of the improvement in endurance of the electrode fetch section.

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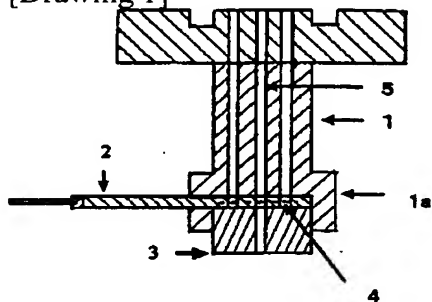
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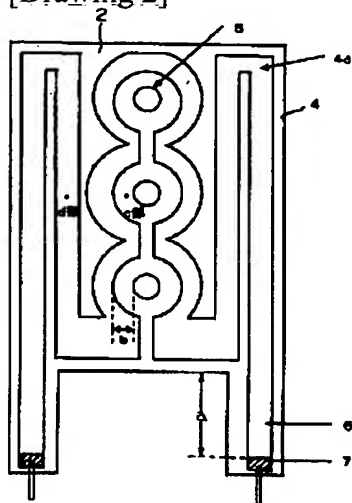
DRAWINGS

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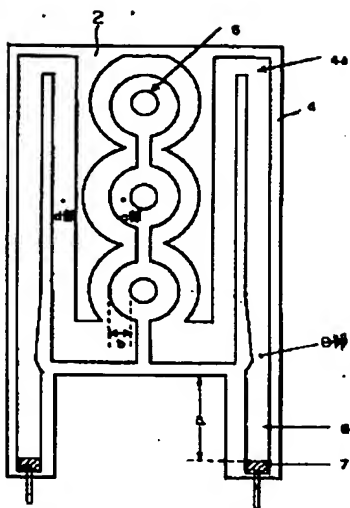
[Drawing 1]



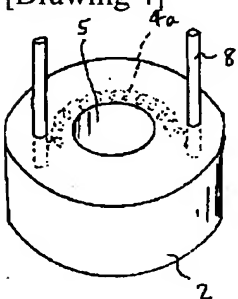
[Drawing 2]



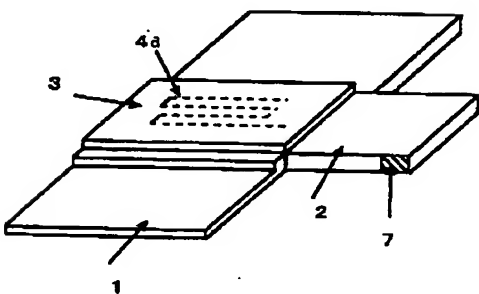
[Drawing 3]



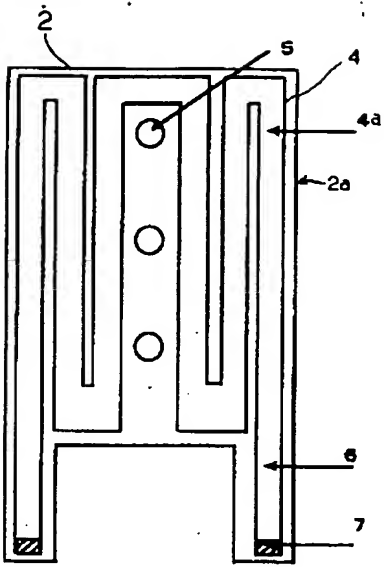
[Drawing 4]



[Drawing 6]



[Drawing 5]



[Translation done.]